THE EFFECT OF MECHANICAL TREATMENTS ON PHYSICAL AND SENSORY CHARACTERISTICS OF PORK LOINS

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ABSTRACT

The objective of this study was to determine if different mechanical treatments have an effect on the physical and sensory characteristics of boneless pork loin chops. Boneless pork loins were mechanically processed by being injected (INJ), tumbled (TUM), or injected and tumbled (COMBO) using a standard brine solution containing water and sodium tripolyphosphate (STPP). A target percentage of 12% was set for INJ, TUM, and COMBO. Results showed treatments were similar ($P > 0.05$) in processing yield. Processing technique had the largest effect on sensory traits with INJ being juicier ($P < 0.05$) than COMBO. In contrast, tenderness was greater ($P < 0.05$) in TUM compared to COMBO. Panelist were able to detect differences in tenderness not found with WBSF. In general, injection seems to be a positive alternative to other mechanical processing methods with lesser amounts of purge, cook loss, and acceptable values for juiciness and tenderness.

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INTRODUCTION

Pork, which is also known as "the other white meat", is not actually classified as a white meat, but rather a red meat. Traditionally white meat, like chicken, is known to be low in fat and considered a healthy protein choice.

The pork industry is facing the mounting issue of balancing the amount of fat and lean pork has while considering consumers purchasing preferences. Hogs with more lean tend to have less intramuscular fat (IMF). Higher levels of IMF has shown to have positive effects on flavor and juiciness (Eikelenboom and Hoving-Bolink, 1996). The ideal levels of IMF for positive eating experiences of pork has been reported to be in the range of 2.33% to 3.46% (Brewer et al., 2001). In the past, swine were fed to higher finishing weights, which meant they also had higher amounts of IMF. This was not an issue until health concerns surrounding the levels of fat content surfaced. In an effort to satisfy the health conscious consumers, the pork industry responded by implementing new production practices, which resulted in the current production of leaner hogs.

Today, consumers consider pork to be a leaner and healthier alternative to beef, but are still unsatisfied with the lack of tenderness, juiciness, and flavor. The lack of fat remains to be a primary source of dissatisfaction among pork consumers. Regardless, pork is still popular due to its pricing and the variety it offers compared to other meat options. The pork industry may continue to raise hogs with longer and leaner bodies, but the processing of pork is always changing. Technological advances allow producers to utilize enhancement options that increase tenderness and juiciness, all while improving overall palatability without increasing fat content. The ability to positively enhance pork products while also addressing

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health concerns can result in more consumers buying pork products overall.

Enhancement of pork is the process of adding non-meat ingredients to improve the juiciness, tenderness, and flavor qualities in fresh meat (Meisinger, 2002). The two most common methods of enhancement are injection and tumbling. The process of injection requires a brine solution to be injected directly into the meat with a goal of uniform distribution at a target percentage. These solutions usually contain water and phosphates, and occasionally salt is added as a natural antimicrobial as well as a flavor enhancer.

The process of tumbling utilizes mechanical energy to rotate meat in a drum allowing the meat to fall and collide with metal paddles in a non-uniform pattern. The repetition of falling and colliding is combined with the brine. The massaging effect causes the meat proteins to break and the brine can then be absorbed into the meat. This process is favorable as it tenderizes the meat as well as allowing water and phosphate absorption, which results in more tender and juicy meat product (Hullberg and Lundstrom, 2004). In most cases, processors inject and tumble with the goal of a maximum solution uptake percentage and overall retention. However, higher concentrations of phosphates can have negative effects on sensory traits (Sheard et al., 1999). Although many studies have investigated the effects of injection in terms of pump rates, tumbling in terms of time and rotations, and the effects of phosphates in brine solutions, little research has been done evaluating the effects of the two mechanical processes separately and combined using a base line solution containing phosphates.

The objective of this study was to determine if the type of mechanical treatment has an effect on the physical and sensory characteristics of boneless pork loin chops.

LITERATURE REVIEW

Phosphate

The use of phosphates in meat is desirable due to their ability to increase water binding capacity within the meat proteins, which also increases overall yield. Tenderness and juiciness have been reported to increase with the addition of phosphates in a brine solution as well (Baublits et al., 2006). Hamm (1960, 1970) found that by increasing phosphates and in turn increasing water holding capacity, meat will have 1) an increased pH, 2) increased ionic strength, 3) ability to sequester metal ions, 4) ability to bind meat proteins, and 5) the ability to break actin-myosin cross bridges. These effects are all important, especially the increased pH and the ability to break actin-myosin cross bridges. Phosphates have shown to produce slight increases in pH from 0.1 to 0.3 pH units depending on the type and concentration of phosphate used in meat (Ranken, 1976). Trout and Schmidt (1983) found increases were higher in uncooked meat products enhanced with phosphates compared to cooked products which were also enhanced with the same concentration of phosphates, with reported increases ranging from 0.1 to 0.7 pH units in the uncooked meat products. The increase in pH creates a protein with a higher affinity for water. The water is tightly bound to the protein and results in a reduction of drip loss or purge. The bound water can also influence sensory traits such as juiciness.

Purge Loss

The ability of proteins to hold water is measured in terms of water holding capacity (WHC). This term refers to the ability to bind and hold water under the presence of external forces such as fabrication or processing. The amount of water retained can be directly affected by the ultimate pH of fresh meat before processing and Baublits et al. (2006) found when injecting sodium tripolyphosphate (STPP) and sodium chloride (NaCl) at three pump rates of 0%, 6%, and 12%, the ultimate pH increased respectively. In correlation to the reported ultimate pH levels, the purge loss decreased as pH increased. The increase in pH is a result of the added phosphates (Hamm 1960, 1970). The isoelectric point of meat is 5.1, this means as the pH approaches this point, the water binding ability decreases, and more water is released in the form of purge. Purge loss can be an early predictor of potential cook loss, and further sensory attributes like tenderness and juiciness.

Cook Loss

Similar to purge loss, cook loss is the amount of water expelled during the cooking process. According to Baublits et al. (2006), cook loss was significantly lower ($P < 0.05$) for both enhanced pork loin pump rates of 6% and 12% versus the control of 0%, but did not differ significantly between 6% and 12%. These results differ from the findings reported by Hayes et al. (2006), who found no significant differences ($P > 0.05$) in cook loss when comparing control pork loins to those enhanced with a STPP. These findings suggest that factors other than pump rate such as phosphate concentrations, end point temperature, or cooking method may cause differences in cook loss percentage.

Injecting

Injection is a popular way to increase yield. It is a well-known fact that by using solutions containing phosphates, not only is yield affected, but also the tenderness and juiciness. Sheard et al. (1999) concluded that tenderness and juiciness can be improved with the addition of 0.25 – 0.5 g of phosphate per 100 g of meat. Currently the USDA restricts the amount of phosphate injected to no more than 0.5% in finished goods (Romans et al., 2001). The percentage injected is calculated using the initial raw weight also known as “green weight" and the weight after injection. Typically, pump rates range from 6% to 12%, but some studies have targeted 30% and 40% while utilizing both injection and tumbling (Patrascu et al., 2011). Sheard et al. (1999) found it difficult to inject solely water at target rates of 5% and 10% and found a majority was lost after 3 days. In the same study, when injecting loin sections with a 5% phosphate concentration at pump rates of 5% and 10%, the percentage of purge loss was minimal for both and did not differ significantly ($P > 0.05$). The inclusion of phosphates show the aided water retention.

Tumbling

Tumbling is usually used in combination with injection to further aid distribution of the brine solution, increase the frequency of actin-myosin cross bridge breaking, and enhance textural properties. Several variables are involved when using tumbling as an enhancement application. Factors such as tumbling time, tumbling being continuous or intermittent, the speed of the drum, drum size, percentage of drum filled, oxygen availability (vacuum), and several others ultimately effect quality and sensory attributes. Therefore, identifying parameters can be difficult.

The time tumbled and whether it is continuous or intermittent is a focus in research currently. Hullberg and Lundstrom (2004) found intermittent tumbling for four hours to have positive effects on tenderness but did not significantly affect juiciness. Hullberg and Lundstrom (2004) also reported consumers preferred the non-tumbled cured hams opposed to the tumbled hams. The lack of juiciness and the negative consumer satisfaction could be a result of reduced tumbling time as well as using intermittent tumbling versus continuous. Patrascu et al. (2011) found continuous tumbling up to 9 hours to have positive effects on tenderness with lower shear force values on the biceps femoris muscle removed from the ham. Results also showed higher percentages of cook yield with increasing tumbling time for all 9 hours. Currently no studies have analyzed brine absorption and the effects of tumbling alone. Several studies research the effects of certain tumbling factors, but also use an injection method prior to tumbling.

MATERIALS AND METHODS

Meat Selection and Enhancement

Pork loins (n = 40) (NAMP# 413 Loin, Whole, Boneless) were purchased from a USDA inspected establishment. The loins were removed from their original packages and randomly assigned to one of four treatments with 10 loins per treatment. The four treatments were: 1) no enhancement (CON), 2) injection of 12% water and 0.5% sodium tri-polyphosphate (INJ), 3) vacuum tumbling with a brine solution consisting of 12% water and 0.5% sodium tri-polyphosphate for 1 hour (TUM), 4) injection of 12% water and 0.5% sodium tri-polyphosphate with subsequent vacuum tumbling for 1 hour (COMBO).

Before each treatment, loins were laid fat side down and three pH readings were recorded. Loin pH was measured using a HANNA meat pH meter (Model HI 99163, Woonsocket, RI, USA). The probe tip was inserted directly into the muscle and measured at one anterior, middle, and posterior location. The three readings were recorded and then averaged. Afterwards, all loins were individually weighed and preprocessing weight was recorded. Identification of loins was kept using deadlock pins to ensure that loins would not be mixed while transferring from injector to table or in the tumbler.

For treatments INJ, TUM, and COMBO a brine solution was made using a pump formulation that calculated for 12% water and 0.5% phosphate in the finished product (Table 1). The brine was used as needed for all treatments.

Table 1. Brine formulation used for injection and tumbling of pork loins

Ingredients	Weight, kg	% of Finished Product
Water	37.44	12.0
Phosphate	1.63	0.5

Injection was accomplished using a multi needle Gunther injector (Model PI 9-52, Gunther Maschinenbau GmbH, Dieburg Germany). Tumbling was done using a KOCH vacuum tumbler (Model LT-15, Kansas City, MO.). Tumbling time was set to one hour for both TUM and COMBO treatments at $^{-}$18 Hg (8.84 psi) of vacuum pressure. Loins in the TUM treatment were tumbled under vacuum continuously for one hour with no prior injection. Loins in the COMBO treatment were first injected for a target of 12% and then weighed for a total treatment weight. The remaining brine needed to reach 12% was calculated and then added to the tumbler. Following enhancements of all treatments, loins were weighed and processing weight was recorded accordingly. Lastly, the loins were individually vacuum packaged using an Ultravac (Model 2100, KOCH Equipment, Kansas City, MO) and stored at 4℃ for 7d to obtain equilibrium.

Purge

After the equilibrium period of 7 d, the purge, or free juices, in the bag were measured. In order to measure purge, the packaged product was weighed unopened. The bag was then opened, the meat was removed, and both the meat and bag were dried. The meat was dried by blotting the surface to remove excess fluids. The pressure used to blot the meat was considered to ensure that only the minimal force needed to absorb surface and not interior moisture was applied. The bag was then dried by inverting the bag and wiping the moisture away. Lastly, the dried meat and bag were both reweighed. The resulting equation was used determine purge:

Purge Loss % = ((weight of sealed bag - weight of dried meat and dried bag) / weight of sealed bag) × 100

Sample Processing

After purge loss data was recorded, loins were arranged in order to begin cutting chops. Chops were cut 2.54 cm thick starting at the posterior end of each loin so that all chops would have the *longissimus dorsi* muscle and not include the *spinalis dorsi* found in the anterior portion. The first 5.08 cm posterior section was cut for proximate analysis testing. After the proximate analysis section was removed individual 2.54 cm chops were cut. The first four chops (1 – 4) were utilized for Warner-Bratzler shear force (WBSF) testing, the next four chops (5 – 8) were assigned to trained sensory panels, and the remaining section was vacuum sealed and frozen (Figure 1). Chops were vacuum sealed two chops per bag following cutting. The chops were then transferred to a freezer to be frozen at $^{-}$17.77℃until thawed for intended analysis.

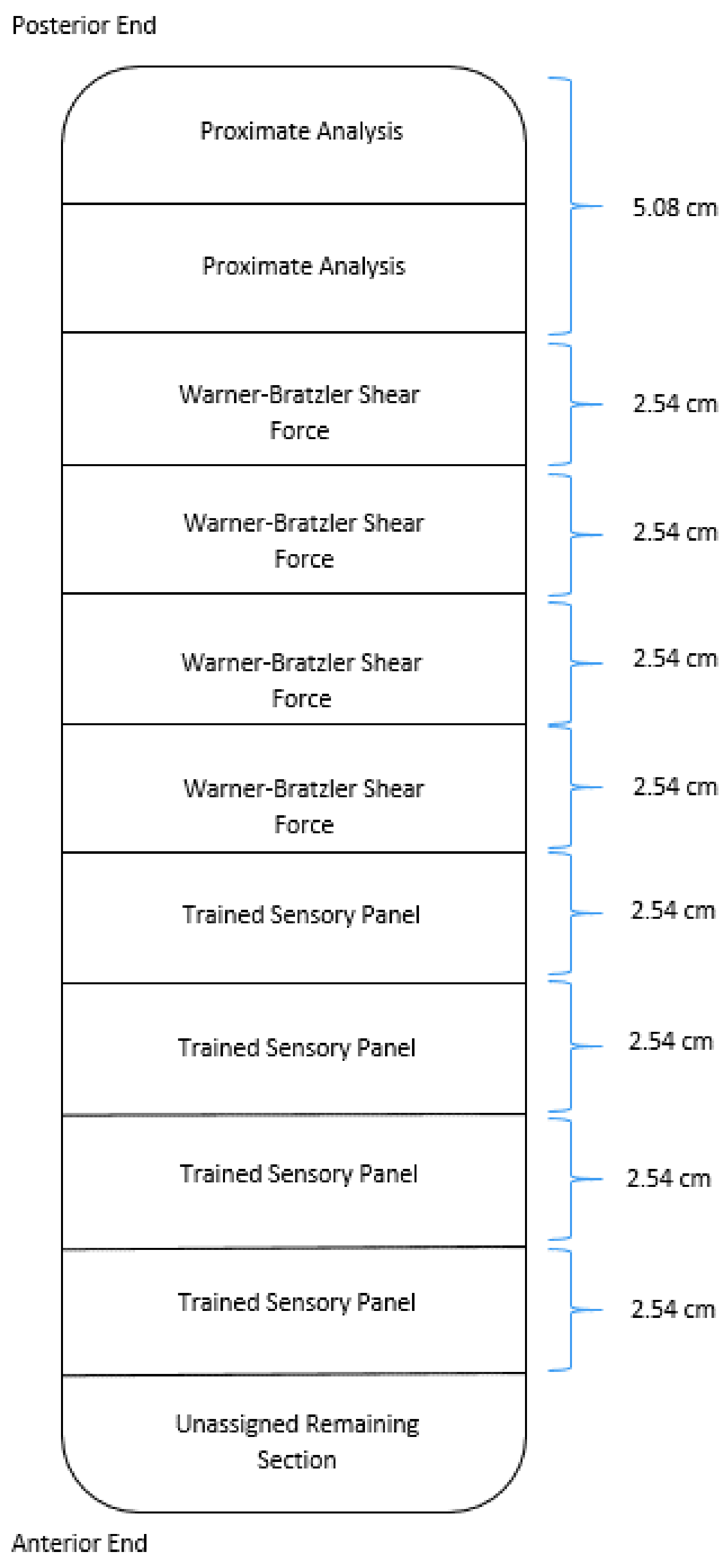

Figure 1. Individual pork chop cutting order and assignment of pork loins

Proximate Analysis

The 5.08 cm sections utilized for proximate analysis were left raw and untrimmed. The sections were removed from refrigeration immediately before sample preparation. Each section was cut into smaller uniform pieces to aid grinding through a 6.35mm plate. After each sample, the grinder was disassembled and cleaned to remove residual fat and protein build up. The ground sections were then individually packed into sample cups and placed in the Foss® Foodscan™. The method of sample collection and analyzing followed the Foss® Foodscan™ (Eden Prairie, MN) manufacturer guidelines for protein, moisture, fat, and collagen.

Trained Sensory Panels

Trained sensory panels were conducted according to the American Meat Science Association Guidelines (AMSA, 1995). All testing involving human participants was approved by the Angelo State University Institutional Review Board (#KEL-060319). Chops were thawed 24 h prior to cooking at 4℃. The thawed chopswere then cooked on a clamshell grill (Calphalon®,Southern Pines, NC) to an internal temperature of 71℃ and monitored using a thermocouple probe to ensure the target internal temperature was met. After cooking, chops were cut into uniform cubed pieces measuring 1.27 cm x 1.27 cm x 2.54 cm using a sensory grid. The samples were then placed in holding pans to aid in maintaining temperature until served. Sensory panels were conducted in a red-light environment. Panelist ranked samples on a hedonic scale of 1 – 8 for initial and sustained juiciness, initial and sustained tenderness, and flavor intensity. A hedonic scale of 1 – 4 was used to determine off-flavor. Water, apple juice, and unsalted crackers were provided to panelist to cleanse their pallet between samples and before each panel began.

Warner-Bratzler shear force

Chops were weighed raw and cooked and the start and end temperatures were recorded. All chops were cooked using a Calphalon® (Southern Pines, NC) clam-shell grill. Chops were cooked until an internal temperature of 71˚C was reached. Temperature was measured using an OMEGA thermocouple (Stamford, CT, Model RDXL4SD). After cooking, chops were chilled for 24 hr at 4˚C. After chilling, six 1.27-cm diameter cores were removed from each chop with an orientation parallel to the muscle fibers. Cores were removed by exposing the muscle fibers with a knife and visually identifying fiber direction. The cores obtained were sheared using the Warner-Bratzler shear force Instron Universal Testing Machine (Manhattan, KS) and the peak value was recorded in kg.

Cooking Loss

Cooking loss was measured by weighing the raw loin chop before cooking, cooking the loin chop, and then reweighing the cooked loin chop. The difference between the raw and cooked chop weight divided by the raw weight was the total cooking loss percentage. The resulting equation was used to determine cooking loss:

Cooking loss = ((weight of raw chop-weight of cooked chop)/weight of raw chop) x 100.

Cooking loss data was obtained from the cooking processes for WBSF and trained sensory panels.

Statistical Analysis

Data was analyzed using the MIXED models procedure of SAS (SAS Inst. Inc., Cary, NC). Loin processing as well as sensory characteristics were analyzed by a completely randomized design with the fixed effect as mechanical treatment. The experimental unit was each individual package. If the treatment effect was significant, then all possible pairwise comparisons were performed using the PDIFF option at the treatment level and considered statistically different at $P \leq 0.05$.

RESULTS AND DISCUSSION

pH and processing yield

The effects different mechanical processing had on pH and processing yield are shown in Table 2. The results of pH were not a direct effect of treatment but rather the effect from random assignment to treatment. This study was designed to determine if the type of mechanical processing used can cause effects in processing and sensory attributes. Even though this study did not influence the ultimate pH directly, pH is important due to its known influence on quality and sensory characteristics. Bidner et al. (2004) reported when pH of the *Longissimus thoracis* increased positive effects for pork quality such as reduced drip loss, purge loss and WBSF values were seen. In this study, the pH of CON loins did not differ significantly ($P > 0.05$) when compared to loins assigned to the TUM treatment with pH values of 5.68 and 5.62, respectively. Similarly, loins assigned to INJ and COMBO treatments did not differ significantly from each other ($P > 0.05$), but both were significantly ($P < 0.05$) lower than CON and TUM. All treatment values fell within the range for acceptable pH values of postmortem meat, but the significant differences among them could account for differences found in the quality and sensory attributes.

All treatments were similar with no significant ($P > 0.05$) differences in processing yield except for CON which was not considered processed. According to Gao et al. (2015a), continuous tumbling of 8 h was most beneficial for increasing yield and water binding

Table 2. Pre-processing pH of pork loins and the effects of different mechanical processing methods on processing yield of pork loins (n = 40)

	Treatment[1]				
Trait	CON	INJ	TUM	COMBO	SEM[2]
pH	5.68^{x}	5.49^{y}	5.62^{x}	5.46^{y}	0.02
Processing yield (%)	0.00^{x}	10.97^{y}	10.87^{y}	11.49^{y}	0.57

^{x,y,z} Least-squares means within a row for each trait lacking a common superscript differ ($P < 0.05$).

[1]Treatment: CON = Control; INJ = Injection; TUM = Tumble; COMBO = Injection + Tumble

[2]SEM = standard error mean

capacity in pork loins utilizing a marinade consisting of 0.22% of phosphates, which is less than half of the amount used in this study. This study did use the continuous tumbling method for 1 h but according to Gao et al. (2015b), increasing the tumbling time could have positively increased yield. Because processing yield for all processed treatments did not differ significantly ($P > 0.05$) and agrees closely with the intended results of achieving target percentages of 12%, processing was considered successful.

Purge Loss

Purge was measured on day 7 after processing and the results are shown in Table 3. Purge is unappealing to consumers and is associated with an inferior product. The different methods of mechanical processing used in this study were anticipated to decrease purge by utilizing mechanical means and increased water holding capacity (WHC) seen with phosphates. However in this study, purge loss was significantly lower ($P < 0.05$) in CON with a loss of 1.37%. This disagrees with Detienne and Wicker (1999) who in a similar study found purge loss to be lowest in a treatment injected with 0.45% sodium tripolyphosphate. Unlike the current study with a smaller range of 1.37% - 3.72%, Detienne and Wicker (1999) had purge loss ranging from 21.8% - 73.8%. When comparing INJ and TUM, a significant difference ($P < 0.05$) was found with TUM having more purge loss. There were no differences ($P > 0.05$) found when comparing COMBO to either INJ or TUM. Baublits et al. (2006) reported a correlation between pH and purge loss whereas pH increased, purge loss decreased. This study did not have similar results. The current study does suggest injecting pork loins compared to tumbling can cause less purge loss. Injecting pork loins can also be a quicker process compared to tumbling. In some small production settings, a faster process that results in less purge can be very beneficial.

Table 3. The effect of different mechanical processing methods on purge loss (n = 40), cook loss (n = 320), and Warner-Bratzler shear force (WBSF) (n = 160) on pork loins

	Treatment[1]				
Trait	CON	INJ	TUM	COMBO	SEM[2]
Purge loss (%)	1.37^{x}	2.84^{y}	3.72^{z}	3.21^{yz}	0.29
Cook loss (%)	12.18^{x}	12.21^{xy}	13.04^{y}	12.84^{xy}	0.31
WBSF (kg)	2.87^{x}	2.46^{y}	2.46^{y}	2.53^{y}	0.06

x,y,z Least-squares means within a row for each trait lacking a common superscript differ (P < 0.05)

[1]Treatment: CON = Control; INJ = Injection; TUM = Tumble; COMBO = Injection + Tumble

[2]SEM = standard error mean

Cook Loss

Cook loss was similar between treatments with only CON and TUM differing significantly (*P* < 0.05) as shown in Table 3. CON cook loss values were significantly (*P* < 0.05) lower than TUM values, but did not differ compared to INJ or COMBO. Cook loss among INJ, TUM, and COMBO were all similar (*P* > 0.05). According to Baublits et al. (2006), chops enhanced at either 6% or 12% with a solution of 0.4% STPP and 1.0% NaCl had lower (*P* < 0.05) cooking losses than chops left untreated, the current study did not have similar results. The CON was not different (*P* < 0.05) from INJ or COMBO suggesting other factors influenced cooking loss. In previous studies such as those conducted by Baublits et al. (2006) and Hayes et al. (2006), the cooking method and cook loss determination calculation was different. The changes in cooking method and determining cook loss may explain the differences in findings.

Warner-Bratzler Shear Force

There were no differences (*P* > 0.05) among INJ, TUM, and COMBO when comparing WBSF values. CON shear force however was significantly (*P* < 0.05) higher than all other treatments. Sheard and Tali (2004) suggested injection can increase water content and weaken the protein structures resulting in decreased shear force values. Sheard and Tali (2004) also found that among several different solutions injected, shear force values all decreased when compared to a control. These findings agree with the current study and suggest again that due to the lack of processing enhancement in CON, less water and undisturbed protein structures resulted in a higher shear force value.

Proximate Analysis

Protein, moisture, fat and collagen were all analyzed following treatment with results shown in Table 4. Protein was similar among treatments with the exception of CON, which contained higher protein percentage levels ($P < 0.05$) than both TUM and COMBO. Moisture results were predictable with INJ, TUM, and COMBO all being similar and significantly higher ($P < 0.05$) than CON. Fat content was similar to the results found for protein where INJ, TUM, and COMBO were all similar but TUM and COMBO were significantly lower than CON ($P < 0.05$). Also, an inverse relationship exist between moisture and fat explaining how CON had higher amounts of fat with a lower moisture content. Collagen was highest ($P < 0.05$) in CON comprising of 0.98%. The levels of collagen varied and only TUM and COMBO were statistically ($P > 0.05$) similar. The natural differences among pork breeds, sex, and age can possibly account for the wide range of collagen content (Hanzelková et al., 2011).

Table 4. The effects of different mechanical processing techniques on proximate analysis values for pork loins (n = 40)

Component, (%)	Treatment[1] CON	INJ	TUM	COMBO	SEM[2]
Protein	20.68^{x}	19.94^{xy}	19.82^{y}	19.49^{y}	0.26
Moisture	64.81^{x}	67.31^{y}	68.67^{y}	69.02^{y}	0.73
Fat	13.49^{x}	11.63^{xy}	10.04^{y}	10.10^{y}	1.03
Collagen	0.98^{x}	0.83^{y}	0.63^{z}	0.66^{z}	0.05

^{x,y,z} Least-squares means within a row for each trait lacking a common superscript differ ($P < 0.05$)
[1]Treatment: CON = Control; INJ = Injection; TUM = Tumble; COMBO = Injection + Tumble
[2]SEM = standard error mean

Trained Sensory Panels

Trained sensory panelist evaluated samples for initial and sustained juiciness and tenderness, flavor intensity, and off flavor (Table 5). Initial juiciness for CON and COMBO were similar ($P > 0.05$) and INJ and TUM were both considered juicier than either CON or COMBO ($P < 0.05$) with scores of 5.51 and 5.39 respectively. Sustained juiciness for chops from INJ pork loins was higher ($P < 0.05$) than CON and COMBO, but was similar ($P > 0.05$) to chops from loins in the TUM treatment. Both INJ and TUM had higher initial tenderness scores compared to CON and COMBO ($P < 0.05$). Chops from the CON treatment was the least ($P < 0.05$) tender for both initial and sustained tenderness scores. TUM was found to be have a higher ($P < 0.05$) sustained tenderness compared to COMBO and CON, but was similar ($P > 0.05$) to INJ. No differences ($P > 0.05$) were found for flavor intensity or off flavor. All treatments were considered slightly/moderately intense with no off flavors. The results suggest overall INJ and TUM have positive effects on eating quality.

Table 5. The effect of mechanical treatment on trained panelist sensory scores of grilled pork loin chops (n = 640)

	Treatment[1]				
Trait	CON	INJ	TUM	COMBO	SEM[2]
Initial Juiciness[a]	4.89[x]	5.51[y]	5.39[y]	5.13[x]	0.09
Sustained Juiciness[a]	5.09[x]	5.77[y]	5.51[yz]	5.34[xz]	0.10
Initial Tenderness[b]	4.87[x]	5.83[y]	5.90[y]	5.53[z]	0.10
Sustained Tenderness[b]	5.13[x]	6.11[yz]	6.16[y]	5.84[z]	0.11
Flavor Intensity[c]	5.97	6.13	6.14	5.99	0.08
Off Flavor[d]	3.94	3.98	3.98	3.96	0.02

[x,y,z] Least-squares means within a row for each trait lacking a common superscript differ ($P < 0.05$)
[1]Treatment: CON = Control; INJ = Injection; TUM = Tumble; COMBO = Injection + Tumble
[2]SEM = standard error mean
[a] 1= extremely dry, 8 = extremely juicy
[b] 1= extremely tough, 8 = extremely tender
[c] 1= extremely bland, 8 = extremely intense
[d] 1= extreme off flavor, 4 = none

CONCLUSION

The objective of this study was to determine if variation in mechanical treatment has an effect on physical and sensory characteristics of boneless pork loin chops. Physical properties such as purge loss was affected most by tumbling followed closely by tumbling combination of injection and tumbling. Cook loss was largely unaffected with both injecting and injecting/tumbling having similar cook loss to the control. Warner-Bratzler shear force values indicated tenderness was lower in the control treatment compared to any given type of mechanical processing. Overall trained sensory panels determined injection or tumbling had a positive effect on both juiciness and tenderness. The combination of injection and tumbling increased tenderness, but did not have a large enough effect on juiciness to be considered advantageous. It would be worth investigating in the future, the effects mechanical treatments have on physical and sensory characteristics of boneless pork loin chops, but in addition to the treatments used in this study, adding a water only brine solution treatment group for injection, tumbling, and the combination of both. Comparing values for purge loss, cook loss, and other sensory characteristics would most likely show how significant the relationship of phosphate inclusion and mechanical treatment type is.

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APPENDIX A

ANGELO STATE UNIVERSITY
College of Graduate Studies
Institutional Review Board

6/3/2019

Dr. John Kellermeier
Department of Agriculture
Angelo State University
San Angelo, TX 76909

Dear John:

The project you submitted to the IRB with your student, Megan Martinez, titled, "*The Effect of Mechanical Treatments on Physical and Sensory Characteristics of Pork Loins*" has been reviewed and approved in accordance with federal regulations 45 CFR 46.

This protocol is approved effective June 3, 2019. If the study will continue beyond one year, please let the IRB know before that time. Please note that any revisions to the protocol and/or materials must be approved by the IRB prior to initiation of any changes. All unanticipated problems involving risks to subjects or others, and any unexpected adverse events must be reported promptly to this office.

The approval number for your protocol is #KEL-060319. Please include this number in the subject line of in all future communications with the IRB regarding the protocol.

Sincerely,

Teresa (Tay) Hack, Ph.D.
Chair, Institutional Review Board

Dr. Teresa (Tay) Hack, IRB Chair | ASU Station #11025 | San Angelo, Texas 76909 Phone: (325) 486-6121 | Fax: (325) 942-2194

BIOGRAPHY

Megan McFarland was born July 7th, 1992 in Abilene, Texas. She graduated from Stephenville High School in 2010. Early on in her college years she had many transitions. She attended Tarleton State, completed a semester abroad in Austria, and studied a few semesters at Austin Community College. In the end, she graduated Cum Laude with her Bachelor of Science from Angelo State University in December of 2016. After graduating she took a year off and then returned to complete her Masters of Science. Her future goals include teaching and focusing on quality control in the meat and food science sectors.